funnel-shaped figure and circulatory movement of the entire mass and the increase of velocity towards the centre will be at once seen.

The descending movement of these whirls may be examined by the preceding analysis, but observation has long since placed the matter beyond doubt. Everyone knows how much eddies in the current of a river are dreaded by bathers; when a swimmer has the misfortune to be caught in one he is drawn down by a rapid rotation even to the bottom of the water. There, the expert swimmer, knowing how to reserve his strength in place of expending it in useless efforts, extricates himself by resting on the bottom, and, disengaging himself from the eddy, rises quickly to the surface. Not only may men be thus engulphed, but masses of floating ice, or even small vessels, are drawn to the bottom by whirlpools, and thereafter are extricated and rise to the surface only by the obstacle afforded by the bottom, and by the contraction downwards, more and more marked, of the whirling mass of water.

These phenomena can be artificially produced in a large mass of still water, at a part where a rapid movement of gyration is communicated by a suitable mechanical appliance.* If we strew dust on the surface, in order to render the phenomena visible, it is seen that gyration is propagated in the form of a cone from above downwards, even to the bottom of the vessel, drawing the dust along with it. Count Xavier de Maistre, who has published in the *Bibliothèque Universelle de Genève* some interesting experiments on this subject, has shown that a layer of oil placed over the water of the funnel-shaped eddy is drawn towards the bottom by a gyratory movement; then, when it comes in contact with the obstacle presented by the base, the oil reascends in globules all round the eddy which it has quitted. There is thus here a double vertical movement—the first regularly descending along the spires of a conical helix, the second ascending and exhibiting in its ascent no geometrical figure, but rising to the surface irregularly *round about* the eddy. It is natural that the liquid thus drawn to the bottom should thereafter ascend more or less, not, be it noted, in the eddy down which it had been carried, but outside it, through the surrounding liquid.

This gyratory movement, which thus concentrates towards the point of the eddy the sum of the moving forces which the funnel-shaped whirl embraces in its vast expanse, ought to produce at its base a certain amount of mechanical work, and observation confirms this idea. The powerful whirlpools of our rivers plough up their beds and thus expend on the soil the force which they have acquired near the surface at the expense of the inequalities of velocity of the general current. And as all currents of water possessing some little depth present like inequalities of velocity among their lateral filaments, on account of the friction of the water against the banks, numerous whirlpools are constantly found whose action consists in finally absorbing these inequalities and regulating the flow of the water, so that the general velocity of the river is perceptibly reduced.

Vortices or Eddies with Vertical Axes in Gases.—All these phenomena are found in gaseous masses traversed by horizontal currents. In currents of this sort, inequalities of velocity will equally give rise to whirling movements round a vertical axis, and, as may be constantly observed, these gyrations will still assume the figure of a truncated cone in an inverted position, which becomes visible when any circumstance occurs to interfere with the transparency of the air. Equally as in the case of water, the gyration of a molecule will be the more rapid the nearer it approaches the centre. The analysis which confirms, or rather explains these phenomena is as applicable to gases as to liquids. Need it be said that waterspouts, from their appearance alone, range themselves in this category? The mechanical identity of whirls formed whether in liquids or in gases is found in all the details—such as the descending movement of waterspouts whose point is seen gradually approaching the earth, and in the abrading force which whirlwinds thus exert on the ground in breaking and beating down objects which obstruct their course—acting thus like a plate fixed perpendicularly at the end of a vertical axis whirling rapidly round. This action evidently ceases when the lower orifice of the waterspout rises a little; it recommences with energy each time that the whirling cone is lowered so as to be brought into contact with any opposing object.

We have only further to prove another characteristic of eddies in a stream of water not less general, in order to complete the study of the analogous phenomena in fluids. At the instant when there is formed in a moving mass of water one of these gyrations which are solely due to inequalities in the general current, it is evident that the eddy thus formed and isolated by an invisible sheath, so to speak, will follow the mean velocity of the current, because nothing can bear away the chief part of the velocity to the molecules which compose the eddy. We shall see it follow the line of the stream, preserving its axis in a vertical position and continuing a longer or a shorter time, or until resistances of every sort have exhausted its force. It will follow the same line of the stream as that taken by a floating object without losing its circular form, and without ceasing to act on the bottom, if it extend so far down, as long as its store of energy is inexhausted.

A distinction must be made between these travelling eddies and the great eddies in deep still water which are ceaselessly formed and re-formed at a post fixed at the turning of narrows of a river. When in such places the current makes itself felt it incessantly bears away with it the spires thus formed; the phenomenon is unceasingly renewed, giving rise to those stationary eddies in rivers which have no analogy to those of thé atmosphere, and which appeared to play an important part in deepening the beds of rivers.

(*To be continued.*)

THE LARGE REFLECTOR OF THE PARIS OBSERVATORY

M. WALLON, the French Minister of Public Instruction, presided on the 7th inst. at the sitting of the Council of the Observatory, and at the end of the *séance* he made an official inspection of the large refractor. On the 9th the representatives of many of the Parisian papers were present at the Observatory by invitation of M. Leverrier; the weather, unfortunately, was very tempestuous.

The telescope was left under its iron house, but every detail was carefully explained by M. Leverrier, assisted by M. Wolff, the chief astronomer for physical observations. M. Leverrier praised very highly the skill displayed by the constructors, MM. Eichens and Martin.

The weight of the moveable part is nine tons; the mirror is 120 centimetres in diameter, with a focal distance of 6·80 metres. The weight of the mirror is only half a ton, instead of four tons, which would be necessary for a metallic one; its cost amounts to 2,000*l*.

The telescope is suspended like a refractor in an ordinary equatorial. The ocular is placed in front.

On the 8th minute stars were observed by M. Wolff with a magnifying power of 500, which has been found to answer excellently. An ocular multiplying 1,200 times, and perhaps another, 2,400, will be constructed. A micrometer is being made.

The seeker is in front, and can be rotated with the

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* These experiments must not be confounded with the experiment of water poured into a vessel to which a movement of rotation round a vertical axis has been communicated. In this case the free surface becomes hollow whilst the water rises along the sides of the vessel. A condition of equilibrium is soon established totally different from the dynamical phenomena we are here discussing. Thus the central depression is parabolical and not conical, and the angular velocity of the fluid molecules is constant, whereas it varies in the movements of eddies in the inverse proportion of the distance from the axis of rotation.

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ocular and the small plane mirror round the axis of the tube by a very simple process. The reason of this arrangement is to facilitate the use of the large iron winding staircase. This enormous metallic structure is moved by special machinery on two circular iron rails. It is always placed on the same side of the tube as the counterpoise, which would render observations impossible if the ocular and seeker were not rotated round the axis of the tube. The height of the iron staircase is about twelve metres, and its weight six tons. The observations are made in open air, and when the weather is propitious the cabin protecting the apparatus is removed by machinery. It is an iron casement (weight twelve tons), moveable on rails. In less than a quarter of an hour the telescope can be directed on any object, however minute.

The clock is finished, but not adjusted. The machinery for moving in right ascension is finished and works admirably. The handle and screws for minute motions in declination are finished and working most nicely. So does the gear for connecting and disconnecting the tube with the clock.

The cost of the reflector is 8,000*l.* It was built in six years, but the work was interrupted several times, first by the dismissal of M. Leverrier, secondly by the war and the Commune.

M. Leverrier is justly proud of having completed the large refractor, to which a very few details only are wanting—the adjustment of the clock, the handles for slight equatorial motions, and the machinery for large declination motions. He asked M. Wallon to give orders for the construction of the large refractor, and it was granted at once. A sum of 8,000*l.* has been already voted by the National Assembly for that purpose. It will be seventeen metres in length, and the construction will be completed in three years, if the work is not interrupted by any political or other commotion.

LIEUT. WEYPRECHT ON ARCTIC EXPLORATION

We have already (vol. xii. p. 460) referred to Lieut. Weyprecht's paper on the Principles of Arctic Exploration, read at the German Scientific and Medical Association. A full report of the paper has now come to hand. Lieut. Weyprecht rightly maintains that the polar regions offer, in certain important respects, greater advantages than any other part of the globe for the observations of natural phenomena—magnetism, the aurora, meteorology, geology, zoology, and botany. He shows that hitherto immense sums have been spent and much hardship suffered for the mere purpose of extending geographical and topographical knowledge, while strictly scientific observations were regarded as holding only a secondary place. While admitting the importance of geographical discovery, he maintains that the main purpose of future Arctic expeditions should be the extension of our knowledge of the various natural phenomena which may be studied with so great advantage in these regions.

After showing in some detail the kind of observations which would yield valuable results, Lieut. Weyprecht lays down the following general propositions:—1. Arctic exploration is of the highest importance to a knowledge of the laws of nature. 2. Geographical discovery in these regions is of superior importance only in so far as it extends the field for scientific investigation in its strict sense. 3. Minute Arctic topography is of secondary importance. 4. The geographical pole has for science no greater significance than any other point in high latitude. 5. Observation-stations are to be selected without reference to the latitude, on account of the advantages they offer for the investigation of the phenomena to be studied. 6. Interrupted series of observations have only a relative value.

Suppose that stations were established at Novaya Zemlya, 76°; Spitzbergen, 80°; West or East Greenland, 76°-80°; N. America east of Behring Strait, 70°; Siberia at the mouth of the Lena, 70°, there would thus be a girdle of observatories around the entire Arctic region. A station in the neighbourhood of the centre of magnetic intensity is much to be desired. By means of the stations already existing in the neighbourhood of the polar circle, a connection would be established with our own region. The cost of one geographical exploring expedition would supply the means of keeping up these stations for a year. The object of these expeditions would be, with similar instruments and according to similar instructions, to record simultaneous observations as far as possible throughout a year. In the first line would be placed the various branches of Physics and Meteorology, as also Botany, Zoology, and Geology; and first in the second line, detailed geographical exploration. Were it possible to establish stations for simultaneous observation in the Antarctic regions, results of much higher value might be expected. Were the cost of these yearly expeditions divided among various countries, it would fall very lightly upon each.

While we think the curiosity of a healthy kind which seeks to know the configuration of the entire surface of our globe, we are sure every man of science will admit the value of Lieut. Weyprecht's propositions. There has, without doubt, been hitherto too much weight attached to merely reaching a high latitude, and too little provision made for strictly scientific observation. Lieut. Weyprecht's suggestions deserve the serious consideration of all civilised countries; were they adopted as a ground for action, a new era in polar exploration would be begun, and results of far higher value than any hitherto obtained might with certainty be expected.

NOTES

It is rather disappointing that Capt. Young's Arctic Expedition in the *Pandora*, which arrived at Portsmouth on Saturday, should have returned home prematurely without accomplishing any part of the work for which it was organised—the discovery of additional Franklin relics and the complete navigation of the North-west Passage. Under the circumstances, however, Capt. Young has adopted the wisest possible course. Better that the expedition should spend a comfortable winter at home, and set out early next year to renew the attempt in which they have just been baffled. Disco was reached on August 7, Upernivik on the 13th, and Cape York on the 16th, after a splendid passage through the much-dreaded Melville Bay. Carey Islands were visited to deposit letters for the *Alert* and *Discovery* and to obtain a despatch from Capt. Nares, as previously agreed on. The despatch, however, was not discovered till the return voyage. From Carey Islands the *Pandora* proceeded up Lancaster Sound to Beechey Island, which was reached on the 26th. Here Capt. Young inspected "Northumberland House," which was built as a storehouse by the *North Star* (Capt. Saunders) in 1850. It was found that the house had been broken into by bears, and many of the stores damaged, but those in casks and barrels had sustained scarcely any injury. The yacht *Mary* and two lifeboats left by Sir John Ross were in such good condition that, with a few repairs, they could still be made seaworthy. After putting the stores in order, Capt. Young proceeded up Peel Strait for the purpose of reaching King William Land. After considerable manœuvring with the ice, and some difficulties arising from the uselessness of the compasses so near the magnetic pole, La Roquette Island, near Bellot Strait, was reached on August 30. The ground thus far gone over was pretty well known from the explorations of previous expeditions, and Capt. Young was close to his former encampments when travelling from the *Fox* in 1859. But now an impenetrable pack of ice across the channel barred all further progress, and after vainly trying to find a

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